PATENT SPECIFICATION

578,392

Application Date: April 19, 1944. No. 7260/44.
" " April 19, 1945. No. 9798/45.
One Complete Specification left (under Section 16 of the Patents and Designs Acts, 1907 to 1942): May 15, 1945.
Specification Accepted: June 26, 1946.

PROVISIONAL SPECIFICATION

No. 7260, A.D. 1944.

Improvements in Multi-cylinder Pumps

We, PRECISION DEVELOPMENTS COMPANY LIMITED, a British Company, of 3, St. James's Square, London, S.W.1, GEORGE OLAH, a Hungarian citizen, of 23, Oaklands, Argyle Road, London, and LASZLO ROSSZ, a Hungarian citizen, of 16, Lichfield Road, Kew Gardens, London, do hereby declare the nature of this invention to be as follows:—

This invention relates to multi-cylinder pumps, and more particularly to multi-cylinder pumps with radially arranged cylinders rotating about a stationary valve member which during the rotation of the cylinder block alternately connects the cylinders with the suction and the delivery side of the hydraulic system.

Pumps of this kind in which cylindrical pistons are operated by intermediate guiding members from an eccentric, stationary, or rotating, track rings, are well known in the art.

The disadvantage of these known arrangements is that the guiding members, especially in high pressure pumps are subjected to a very considerable mechanical strain and wear and are expensive to manufacture.

Furthermore, pumps of this kind in which cylindrical pistons operate directly without intermediate guiding members on eccentric track rings, are well known in the art, the disadvantage of these arrangements being that the piston ends contacting the track rings are subjected to a sliding motion under full load, which causes considerable wear of the piston ends. Furthermore, the side pressures created by the friction due to the sliding motion have the tendency to wear out the cylinders.

The object of this invention is to provide simple means of avoiding these disadvantages.

According to this invention the operating elements in the cylinders are in the form of balls contacting an eccentric track ring without any intermediate members. With this arrangement the balls roll on the track ring and thus a sliding motion under full load, between the track ring and the balls, is avoided. The remaining sliding motion between the ball and cylinder occurs at loads which are only a small fraction of the hydraulical load imposed on the balls. The track ring, on which the balls roll, may be either stationary or, preferably, in the case of high speed pumps, rotating on roller, ball, or plain bearings.

In one modification of this invention, the rotary track ring is arranged to rotate freely, driven by the friction between balls and track ring. In a further modification of this invention, the rotary track ring is driven by appropriate means at the same speed, or approximately the same speed as the rotary cylinder block. The driving means may consist of couplings, for instance of the Oldham type, or of gears. The arrangement comprising a freely rotating or driven track ring, has the advantage that the relative sliding between the balls and cylinders is reduced to a minimum value, thus, in conjunction with the small loads on the sliding surfaces, keeping wear at a minimum.

In one form of this invention, the cylinder block may consist of a single member, provided with a number of cylinder holes.

In a further form, the cylinder block may consist of a main body in which for each cylinder, individual cylinder sleeves are inserted. The main body may be arranged to run directly on the internal valve member, or alternatively, an intermediate bush may be inserted.

The rotary cylinder block may be connected by any kind of coupling, to the driving shaft. However, it is preferable to use an Oldham type of coupling between the rotary cylinder block and the driving shaft, and to derive the rotary motion of the eccentric track ring by an Oldham type of coupling from the driving shaft as well.

In the type of pump proposed in this invention, the balls are kept in contact during the suction period with the track ring, mainly by centrifugal force, but a centrifugal rotor may be fixed on the driving shaft and provide the cylinders, during the suction period with low pressure fluid, this low pressure increasing

the effect of the centrifugal force in pressing the balls against the track ring, thus enforcing a perfect contact under any conditions. The surplus of the pump fluid from the low pressure stage may be returned by a valve, or restriction, to the inlet.

The pressure oil between the valve member and the cylinder block normally acts to force the cylinder block from the low pressure side towards the high pressure side. In order to counteract this action the port holes in the cylinder block are made smaller in diameter than the cylinder holes so that the hydraulic pressure in the chamber between the balls and the port holes in the block acts on the annular surfaces formed by the difference in diameter and provides an opposing pressure partly or wholly balancing that acting on the cylinder block.

In order to obtain any desired degree of balance, spaced grooves may be provided extending over the high pressure side only of the valve member which grooves are connected at their ends to the low pressure side of the valve member, these grooves limiting the pressure area which opposes the pressure on the annular surfaces.

The high pressure port on the valve member may have the shape of a comparatively narrow slot. Should one of the balls become jammed in the cylinders during the suction period, due to dirt passing in with the pressure fluid, the narrow slot shaped port on the valve member would restrict the flow of high pressure fluid to the cylinder during the compression period, and thus prevent the jammed ball from being thrown by the force of the high pressure, with too high a speed, against its track.

Dated this 19th day of April, 1944.

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Agents for the Applicants.

PROVISIONAL SPECIFICATION
No. 9798, A.D. 1945.

Improvements in Multi-cylinder Pumps

We, PRECISION DEVELOPMENTS COMPANY, LIMITED, of 3, St. James's Square, London, S.W.1, a British company, GEORGE OLAH, of 23, Oakland, Argyle Road, London, W.13, and LASZLO ROSSZ, of Lichfield Road, Kew Gardens, Surrey, both of Hungarian Nationality, do hereby declare the nature of this invention to be as follows:—

This invention relates to multi-cylinder piston-type pumps of the kind in which balls serve as pistons, and in which the cylinders containing the balls are rotated relatively to a fixed eccentric track ring or swash plate, the eccentricity of the track ring or the inclination of the swash plate causing the balls to perform an oscillatory pumping motion. Pumps of this kind are described in our co-pending application, No. 7260/44.

It will be evident that in pumps of this kind the ball-shaped pistons during operation will roll on the track ring or on the swash plate and glide on the cylinder walls.

The present invention has for one of its objects to reduce the gliding speed of the ball pistons, and consequently the wear of the cylinders.

According to this invention, between the track ring or swash plate and the pistons of a multi-cylinder pump of the type hereinabove described, an intermediate concentric ring is interposed which rotates relative to the track ring or swash plate with substantially the same speed as the cylinders carrying the ball pistons. This intermediate ring member may be supported on the track ring or the swash plate by anti-friction bearings. It may be arranged to be driven by the friction of the main pistons, but in general it is preferred to connect the intermediate ring member to the cylinder block, or to the shaft by which the cylinder block is rotated, by mechanical connecting means, such as gears, a dog clutch, or preferably an Oldham-type clutch, that is to say, by means which allow an oscillatory motion between the member and the block while not allowing any substantial amount of differential rotation.

In order to reduce friction still further in a pump according to the invention in which the ball pistons of radially disposed cylinders co-operate with a track ring disposed eccentrically to the axis about which the cylinders rotate, the intermediate ring member, according to a further feature of the invention, is provided with flat operative inner surfaces opposite and at right angles to the axis of each of the cylinders in which the ball-shaped pistons operate.

It will be readily understood that the present invention will reduce the rolling

and the gliding of the ball-shaped pistons to very small values, and will thus enhance the advantages inherent in ball-shaped pistons, more particularly when cylinders are used which have exchangeable sleeves inserted into the cylinder block with a non-interference fit, such as the liners or sleeves described in our co-pending application, No. 2817/44 (Serial No. 574,991). In addition to the elimination of any necessity of accurate alignment, lateral pressure, which might tend to loosen the liners in the cylinder block, is very largely avoided by the present invention.

Owing to this elimination of lateral pressure, it is possible to maintain a very accurate fit of the piston in the cylinder sleeves for a long time of operation.

So as to prevent the accuracy of the fit from being affected by expansion of the sleeves due to the pressure of the liquid in the cylinder, it is preferred to arrange for the sealing of the sleeve in the cylinder block to be effected near the outer end of the cylinder, thus allowing the internal pressure to act simultaneously on the inner and outer surfaces of the sleeve.

In a pump according to the invention in which the track ring is provided with flat inner working surfaces at right angles to the cylinder axis, most of the driving power will be found to be required by the rotating track ring, this being due to the substantial elimination of any tangential component of the pressure exerted by the track ring upon the pistons in the cylinder block. When the driving power is imparted to the track ring by means of an Oldham or similar coupling of customary design from a shaft that is substantially co-axial with the axis about which the cylinder block rotates, this will result in substantial friction losses and wear in the coupling.

With a view to overcoming these difficulties, according to one feature of the present invention rollers, balls, or similar anti-friction members are interposed between the arms of the Oldham coupling and the driving and driven members thereof, while according to another feature of the present invention the driving shaft is arranged to have its axis at a point substantially between the axis of the cylinder block and the axis of the rotating track ring, with which latter it may actually coincide. It will be evident that in this way, a more efficient drive of the track ring is ensured.

Dated this 19th day of April, 1945.

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COMPLETE SPECIFICATION

Improvements in Multi-cylinder Pumps

We, PRECISION DEVELOPMENTS COMPANY LIMITED, a British Company, of 3, St. James's Square, London, S.W.1, GEORGE OLAH, of 23, Oaklands, Argyle Road, London, W.13, and LASZLO ROSSZ, of 16, Lichfield Road, Kew Gardens, Surrey, both of Hungarian Nationality, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to multi-cylinder pumps of the type comprising a rotary cylinder block in which the pistons are arranged to be actuated by a track ring which is rotatably mounted in the pump casing, for example on a swash plate or in an outer track ring eccentrically surrounding a block of radial cylinders. The invention has for its principal object to provide improved pumps of this type which are relatively inexpensive to manufacture and which are efficient in use and capable of standing long service.

A pump according to the present invention is characterised by the combination, in a pump of this kind, of balls acting as pistons and the provision of means for positively driving both the rotatable track ring and the cylinder block In order to ensure uniform wear of the ball-shaped pistons, the arrangement may be such as to drive the track ring and the cylinder block for rotation at slightly differing speeds. On the other hand, especially when used in connection with some other features of our invention, we prefer arrangements in which the track ring and the cylinder block are driven in angular correspondence with each other, and which thus ensure minimum wear of the ball-shaped pistons. One or more couplings of the Oldham type may be employed for this purpose, and anti-friction means may be incorporated in the Oldham-type coupling for increasing efficiency and reducing wear. According to another optional feature of the invention, the ball-shaped pistons in a pump according to the invention with radially disposed

cylinders are arranged to be respectively actuated by substantially flat inner working surfaces arranged in the rotatable track ring opposite and at right angles to the individual cylinders, the track ring and cylinder block being in this case essentially driven in angular correspondence.

This will further reduce lateral pressure of the pistons in the cylinders, which in the case of ball pistons is generally less than with other types of pistons, and therefore will greatly facilitate the use in the cylinder block of replaceable cylinder sleeves such as described in our co-pending application No. 2817/44 (Serial No. 574,991), these sleeves being preferably inserted in the cylinder block with a non-interference fit.

The absence of lateral pressure will also obviously reduce wear of the cylinder sleeve, and will therefore allow a very small initial clearance between the ball-shaped piston and the cylinder sleeve to be maintained for a long time of operation, thus ensuring a high volumetric efficiency of the pump.

Because the sleeves are relatively thin walled, and in the case of a non-interference fit are not strengthened against expansion by the cylinder block itself, this volumetric efficiency might be impaired by expansion of the sleeve under the internal fluid pressure during operation.

According to a further feature of the present invention, this expansion is greatly reduced if the sealing between the sleeve and the cylinder block is arranged to take place near the outer end of the cylinder, thus allowing fluid under pressure to reach the outer as well as the inner surfaces of the sleeves.

It is preferred to drive both the cylinder block and the track ring from a common driving shaft, and according to one form of the invention at least one Oldham-type coupling is provided between two of the following elements, viz: the driving shaft, the cylinder block, and the track ring.

In the form of the present invention in which flat surfaces are arranged in the track opposite to each cylinder, a substantial torque is required to rotate the track ring. When the driving shaft is arranged co-axially with the rotating cylinder block, the Oldham-type coupling between the track ring of this kind and the driving shaft is therefore subjected to substantial gliding under load. The frictional loss and wear due to this feature will be substantially reduced according to the present invention by providing anti-friction elements, such as rollers, between the floating element and the driving and driven elements of the Oldham coupling, and improvement may also be obtained by arranging the driving shaft substantially between the axis of the rotating cylinder block and the extreme eccentric position of the track ring, with which latter it may even coincide.

Since, except for the effects of friction, only radial forces are transmitted to the cylinder block when a track ring having flat actuating surfaces is provided according to the invention, a positive drive for the cylinder block may be altogether omitted.

In order that the present invention may be more clearly understood, we will now describe it by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a pump according to the present invention, partly in axial section.

Fig. 2 is an elevation substantially corresponding to a section on line 2—2 of Fig. 1, showing a slightly modified pump.

Fig. 3 shows a cylinder sleeve to a larger scale, and

Fig. 4 is a diagrammatic section through a modified Oldham-type coupling according to the present invention.

Referring now more particularly to Figs. 1 and 2, 1 illustrates the driving shaft of a pump according to the present invention. 2 is the cylinder block, which is rotatably mounted on the stationary valve element 3, and is arranged to be driven for rotation by the shaft 1 through an Oldham-type coupling 4. The cylinder block 2 is provided with a number of radial cylinders 5, each having in it a ball-shaped element 6 serving as piston. During rotation of the shaft 1, the pistons 6 are in contact with the track ring 7, which is itself rotatably mounted in a stationary track ring 8. Anti-friction means, such as ball bearings 9, or roller bearings 10, (Fig. 2) are preferably provided between the track rings 7 and 8, and the outer track ring 8 is pivotally mounted on a pin 12 in the pump casing 11. A hydraulic cylinder 13, working against the resetting action of a spring 14, is provided to control the eccentricity of the track rings 7 and 8 from zero to a maximum value. It will be noted that Fig. 2 shows the pump in its position of maximum eccentricity.

The cylinder walls, in the examples shown, are formed by the bores of sleeves 15 which are inserted with a non-interference fit in the cylinder block 2. As will be seen more clearly in Fig. 3, the sleeves may, for example, be secured in the cylinder block by means of a screw

thread 16 of a one-sided saw-tooth type the active flank of which is perpendicular to the cylinder axis. When a sleeve as shown in Fig. 3 is screwed home in the cylinder block and tightened, the pressure acting on the active surface of the screw thread will therefore have no component in a radial direction of the cylinder, thus avoiding any possibility of affecting the diameter of the bore. The sleeves can therefore be machined accurately and finished before they are inserted into the cylinder block. Owing to the non-interference fit, a certain amount of clearance will be left on the inclined flank of the thread, and when, as shown in Fig. 3, the sleeve is arranged to be sealed in the cylinder block at the surface 17 near its outer end, fluid under pressure from inside the cylinder will be able to penetrate along the inclined flank of the thread, so that substantially the same pressure is acting on both sides of the wall of each sleeve 15, thus preventing expansion of the thin-walled sleeves under action of the internal fluid pressure.

The rotatable track ring 7 is driven from the driving shaft 1 by a separate Oldham-type coupling 18. In the form of the invention as shown in Fig. 2, the rotatable track ring 7 is provided opposite each cylinder and at right angles to its axis with a flat surface 19. This excludes any possibility of substantial lateral pressure on the cylinder walls, but owing to the eccentricity of the track ring 7 relative to the driving shaft 1, a substantial torque will be required to rotate track ring 7, while the torque necessary for rotating the cylinder block 2 will be relatively small. In order to reduce the amount of friction and wear in the Oldham-type coupling 18 under varied eccentricity of the track rings 7 and 8, an improved anti-friction type of coupling between the driving shaft 1, and the rotary track ring 7, is preferably used such, for example, as shown in Fig. 4. Part 29 of this improved Oldham-type coupling is fixed on the driving shaft, while part 20 is fixed on the rotating track ring 7, part 21 being the floating element of the Oldham-type coupling. Anti-friction means, such as rollers 22 and 23, are interposed between the floating element 21 on the one hand, and the driving and driven elements 29 and 20 on the other hand. If desired, coupling 4 may be similarly constructed.

It will be obvious that the invention is not limited to the particular features of the illustrated examples, various features of which may be altered without departing from the scope of the present invention. More particularly, although a pump with radially disposed cylinders and a track ring of adjustable eccentricity has been illustrated and described, it will be obvious that the principal features of the present invention may also be used in other types of multi-cylinder pumps with rotating cylinder blocks, such as, for example, swash-plate pumps.

When it is desired to drive the track ring 7 and the cylinder block 2 at different speeds, the driving part of coupling 4 may be arranged on a shaft rotatably mounted in an outer shaft, on which latter the driving part of coupling 18 is mounted, while two gear wheels of slightly different effective diameters may be respectively secured on the other end of these shafts and engage with suitable pinions on the driving shaft 1, which in this case would be disposed at a suitable distance from the common axis of the two first-mentioned shafts. Various other possibilities of effecting a drive at slightly different speeds for the cylinder block and the track ring will be readily available to those skilled in the art.

Finally it may be mentioned that the arrangement of stationary and rotating parts as described may be reversed within the scope of the present invention.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In a multi-cylinder pump of the type specified, the combination of balls acting as pistons with the provision of means for positively driving both the rotary track ring and the cylinder block.

2. A pump as claimed in Claim 1, comprising arrangements for driving the track ring and the cylinder block for rotation at slightly differing speeds.

3. A pump as claimed in Claim 1, in which the track ring and the cylinder block are arranged to be driven in angular correspondence.

4. A pump as claimed in Claim 1, in which at least one coupling of the Oldham-type is provided between two of the following elements, viz: the driving shaft, the cylinder block, and the track ring.

5. A pump as claimed in any of the preceding claims, in which the ball-shaped pistons are arranged to operate in cylinder sleeves which are inserted, preferably with a non-interference fit, in the cylinder block.

6. A pump as claimed in Claim 5, in which the sleeves are arranged to be sealed in the cylinder block near their outer ends, for the purpose specified.

7. A pump with radially disposed cylinders as claimed in any one of Claims 1 and 3 to 6 in which the ball-shaped pistons are arranged to be respectively actuated by substantially flat inner working surfaces arranged in the rotatable track ring opposite and at right angles to their cylinders.

8. A pump with radially disposed cylinders, as claimed in any of the preceding claims, in which the axis of the driving shaft is disposed substantially between the axis about which the cylinder block rotates, and the extreme eccentric position of the axis of the rotating track ring, for the purpose specified.

9. A pump as claimed in any of Claims 4 to 8, in which anti-friction elements such as balls or rollers are interposed between the floating element and the driving, and/or the driven member of the Oldham-type coupling.

10. A pump as claimed in Claim 9, in which two anti-friction Oldham-type couplings are arranged to connect the driving shaft respectively to the cylinder block and to the rotating track ring.

11. A multi-cylinder pump of the type specified, substantially as described with reference to the accompanying drawings.

Dated this 15th day of May, 1945.

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FIG. 4

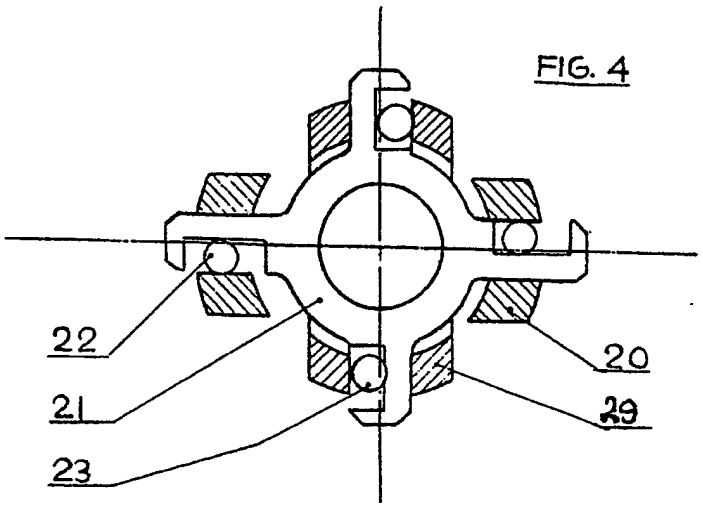


FIG. 1.

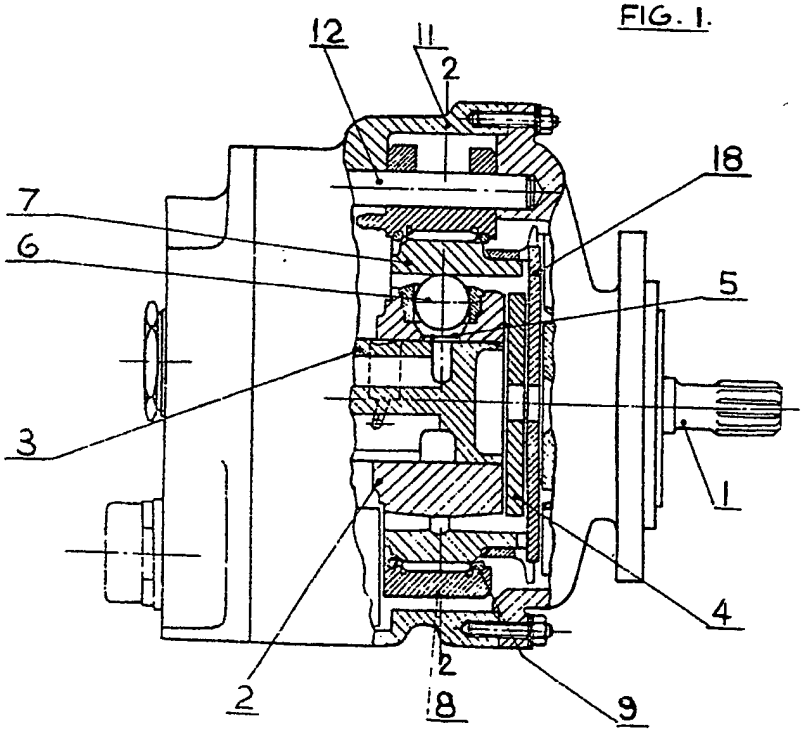


FIG. 3.

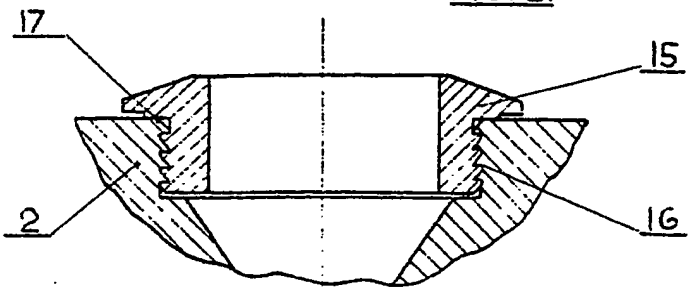


FIG. 2.

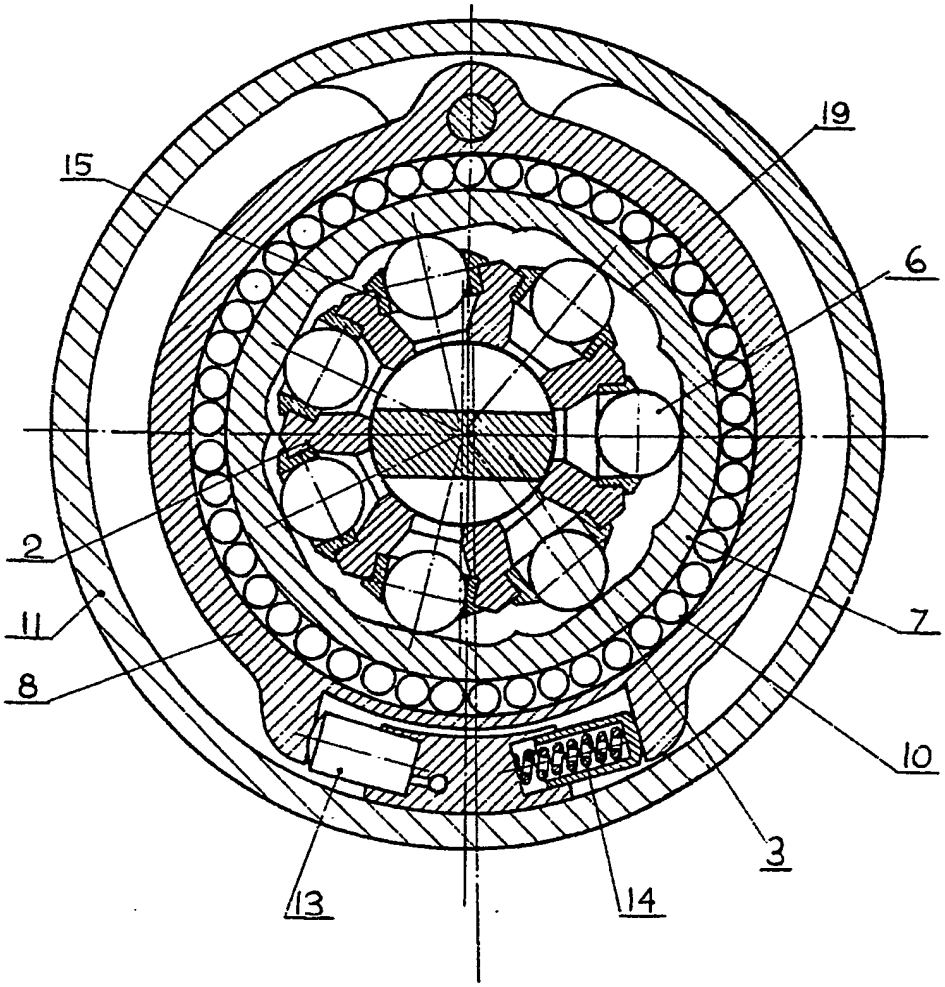


FIG. 4

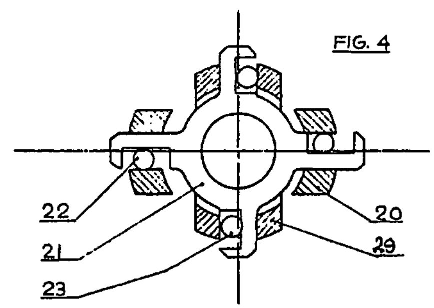


FIG. 1.

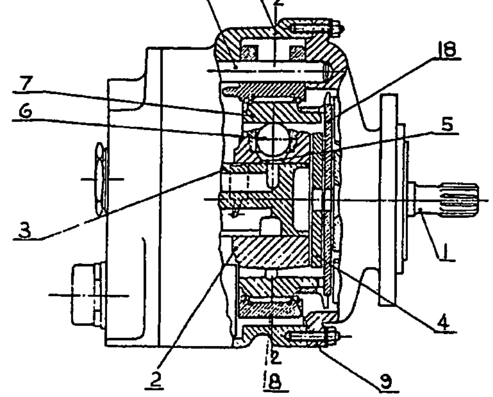


FIG. 3.

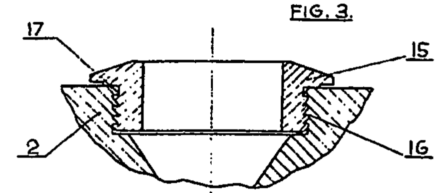
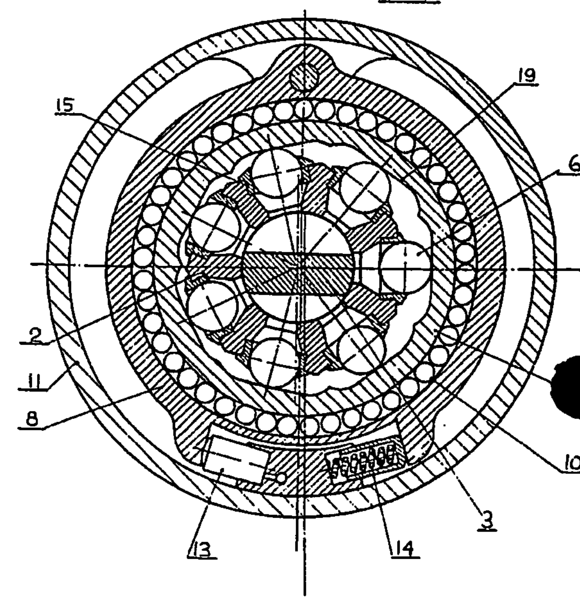


FIG. 2.



[This Drawing is a reproduction of the Original on a reduced scale.]